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GENERAL ELECTRIC CO.
INSTRUMENTATION &
METROLOGY LABORATORY
PHONE (213) 674-7900

INSTRUCTION MANUAL

for

DIGITAL MEASURING SYSTEM

— MAIN FRAME —

the model DMS-3200

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10514 DUPONT AVENUE • CLEVELAND, OHIO 44108

Printed in U.S.A.

HICKOK Precision Test Equipment

DMS-3200

DIGITAL MEASURING SYSTEM

(Fully transistorized)

DMS-3200 Main Frame —
(Shown with DP-100 PI)

MODEL DP100 DC PLUG-IN
MODEL DP150 1MC COUNTER
MODEL DP 170 RESISTANCE PLUG-IN
MODEL DP200 CAPACITOR PLUG-IN
MODEL DP 140 EVENT COUNTER

DP-100
DC Voltmeter
Plug-in

DP-150
1MC Counter
Plug-in

DP-170
Ohmmeter
Plug-in

DP-200
Capacity Meter
Plug-in

DP-140
Event Counter
Plug-in

Prices and Specifications subject to change without notice.

The Hickok DMS-3200 Digital Measuring System is a precision electronic measuring device which displays readings in digital form instead of the relatively inaccurate and difficult-to-read moving-pointer meter display.

Because the DMS-3200 consists of a main frame which will accept a number of "plug-in" units, it can be used to measure a variety of electrical parameters. The main frame provides display of the reading; the plug-in determines the application.

***Depending on the plug-in selected the instrument can be a:**

- Digital DC Voltmeter
- Digital AC Voltmeter
- Digital Counter
- Digital Frequency Meter
- Digital Ohmmeter
- Digital Capacity Meter
- Digital Current Meter
- Digital Multimeter
- Digital Ratio Meter
- Event Counter
- Digital display of time, stress, flow, temperature, etc.
- Linear Multiplier

The DMS-3200 is designed for rugged industrial and laboratory applications. Solid-state construction and conservative design ratings insure long, trouble-free life. By utilizing a design which has the optimum combination of accuracy capability and number of digit display, the DMS-3200 meets the general purpose measurement needs of industry for reliable digital measurement equipment in the $400 - $500 price range.

Additional Plug-In units will be announced periodically by Hickok. All Plug-In units are available through franchised Hickok Industrial Distributors.

THE HICKOK ELECTRICAL INSTRUMENT CO. • 10514 Dupont Avenue • Cleveland, Ohio 44108

DMS-3200
WITH
DP100 INSTALLED

DMS-3200
DIGITAL MEASURING SYSTEM

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2490-561

WARRANTY

The Hickok Electrical Instrument Company warrants instruments of its manufacture to be free from defects in material and workmanship for ninety (90) days from the date of original purchase. Any instrument found to be defective during this period may be returned, transportation prepaid, to the factory for repair, or at our option, replaced without charge.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither shall the warranty apply where a warranty registration card has not been properly completed and returned to us promptly after purchase. This warranty is in lieu of all other warranties whether expressed or implied.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, the factory must first be contacted, giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly either to the Hickok factory address at 10626 Leuer Avenue, Cleveland, Ohio, 44108, or to a designated service station in your locality.

TABLE OF CONTENTS

Specifications 1

Section I - Characteristics 1

General 1
Turn On 1
Power Cable 1
Power Source 1

Section II - Circuit Description 2

Main Frame Counter and Display 2
The Counter 2
The Display 2
Power Supplies 4
The + 20V Supply 4
The - 20V Supply 4
The + 190V Supply 5
The + 3. 6V Supply 5

Section III - Service 5

General 5
The Main Counter Board 6
Display 6
Counters 6
Servicing Printed Circuit Boards 9
Parts List 12

LIST OF ILLUSTRATIONS

1. DMS-3200 Digital Measuring System Main Frame 1

2. Counter Schematic without Provision for Display 3

3. Generalized Wave Forms of the Counter 3

4. Power Supply Block Diagram 4

5. Socket Pin Layout 6

6. Circuitry Which Drives the Number 7 of the First Digit 6

7. Method of Removing a Package from the Board 7

8. Procedure for Replacing Components in Printed Circuit Boards 8

9. Component Locations — Power Supply 10

10. Component Locations — Main Counter Board 11

11. Schematic Wiring Diagram 14

SPECIFICATIONS

Power Source: 115 volt/230 volt ±10%, 47 to 400 cycle AC, 30 watts maximum (16 watts with typical plug-in)

Isolation from 3rd Wire Ground:
1500 volts minimum, (10^9 ohms minimum leakage resistance)

Construction: Fully Transistorized. (No tubes or relays)
High Quality Glass Epoxy (G-10) Printed Circuits
Die Cast and Extruded Chassis

Number of Digits:
3 (overrange capability determined by plug-in)

Readout: NIXIE* Type Gas Tube Readout
decimal points (controlled by plug-in)
± sign (for appropriate plug-ins) wrong polarity indicator (for use with DC voltage measurements)
Overrange indicator (to warn of greater than full scale reading)

Counter Response:
Pulse rates up to 10^6 PPS

* Trademark of Burroughs Corp.

Operating Temperature Range:
0° to 50° C

Size: 9-1/4"w x 6-3/8"h x 12-7/8"d (including handles)

Weight: 10 lbs.

Figure 1. DMS-3200 Digital Measuring System Main Frame

I
CHARACTERISTICS

General

The DMS-3200 Digital Measuring System Main Frame is designed to be used with DP series Plug-ins. The main frame is the mother unit for a series of plug-ins which, when fully developed, will enable measurement of almost any parameter capable of measurement simply by interchanging the plug-in units. The main frame contains the readout devices, which are numerical neon lamps, sequential counting and readout control circuits, and regulated power supplies which power both the main frame and the plug-in which is being used.

The plug-in is inserted into the main frame by slipping it onto the runners provided in the access port of the main frame. The locking shaft should then be turned until the plug-in is securely held into the main frame.

> CAUTION: The power should be turned off when removing or inserting plug-in units.

Controls

The only control contained on the front panel of the DMS 3200 is the power switch. No pilot lamp is provided because the readout tubes light immediately upon application of power.

Turn On

The circuits of the main frame are such that upon application of power several digits of a decade may be displayed simultaneously. A reset pulse will correct this condition. From that time on the unit will operate normally.

Power Cable

The three conductor power cable supplied with the main frame terminates in a polarized three-prong male plug. The third contact is an offset round pin added to a standard two blade plug. This contact does not ground the instrument case. It is connected only to the primary shield of the transformer.

Power Source

This instrument is connected for 115 volt operation in production. For 230 volt operation the connections as shown in the lower left hand corner of the schematic (figure 11) should be made. No fuse change is required.

II
CIRCUIT DESCRIPTION

Main Frame Counter and Display

The main function of the DMS-3200 is numeric display of the number of pulses entered. The display utilizes NIXIE* type neon glow numeric tubes. Three of these tubes allow up to 999 pulses to be entered and read directly. The 1000th pulse is used to turn on an indicator light marked "Overrange" at the same time the number "000" is displayed. Any number of pulses may be entered and the DMS-3200 will display the last three digits of this number and turn on the overrange light if the number exceeds 999. The meaning of the overrange light will depend on the particular plug-in used. Four decimal points are provided and numbered DS1 through DS4, from left to right. Their control and interpretation depend on the plug-in used. In addition to the above, a ± sign and an indicator marked "wrong polarity" are provided and controlled by switching in the plug-in. All the circuitry for accumulation (counting) and display is on one printed circuit board, referred to as the main counter board.

The Counter

The task of accumulating the number of input pulses entered is performed by three cascaded decade scalers. Each decade scaler is composed of 5 RTL JK flip-flops interconnected as a switch-tail-ring counter. This ring counter passes on one output pulse for every 10 pulses entered. Since all three decades are identical, only the first will be examined. Figure 2 is a schematic of the counter without provision for display.

The blocks marked A, B, C, D and E are JK flip-flops. They have inputs called "clear" (c), and "set" (s), and two outputs "0" and "1". There is an input, "toggle", marked T and a "reset" input marked R. To describe their operation, we will call a "0" the presence of a voltage between 0 and +. 3V, and a "1" is the presence of a voltage between +. 7V and + 3. 6V.

The voltages designated as 0's or 1's may be either inputs or outputs. The symbol A_0 refers to the output level of the "0" side of the A flip-flop regardless of what the output level is; i. e., it may be that $A_0 = 0$, or $A_0 = 1$. Similarly, A_1 refers to the output of the "1" side of the A flip-flop, and B_0, B_1, C_0, etc. refer to the outputs of the corresponding flip-flops. Because these circuit blocks are flip-flops, it is necessary that if $A_0 = 0$ then $A_1 = 1$, and if $A_0 = 1$, then $A_1 = 0$.

The JK flip-flop operation may be described by:

1) A positive pulse at the reset input (i. e., R = 1) sets the flip-flop so that the "1" output is 0 (i. e., if R = 1, then $A_1 = 0$, B1 = 0, etc.)

2) If the set and clear inputs are both at 0, then a positive pulse at the toggle input will cause the flip-flop to change states when the pulse returns to 0; i. e., if C = 0, S = 0, $A_0 = 1$, and $A_1 = 0$, then the application of a toggle pulse will produce $A_0 = 0$ and $A_1 = 1$. Another toggle pulse will cause it to switch again to $A_0 = 1$, $A_1 = 0$, etc.

3) If the set input is different from the clear input, then a toggle will cause the output to match the input regardless of the previous state. For example, if C = 1, S = 0, then after the toggle pulse, the outputs will be $A_0 = 1$, $A_1 = 0$.

4) The outputs will remain unaffected by changes in the set and clear inputs provided there is no toggle pulse.

The circuit blocks AR9 and AR10 are buffer amplifiers whose function is to provide sufficient output current to drive the flip-flops. They also invert the signal; i. e., they change 1's into 0's and 0's into 1's. Q44 simply raises the input impedance of the buffer AR9 so that circuitry in the plug-in will not be loaded.

Figure 3 shows the generalized wave forms of the counter starting after a reset pulse has been applied.

The Display

From the foregoing discussion it can be seen that the five-stage ring counter has a unique state which corresponds to the last digit of the number of pulses put in; for example, after starting from reset, 467 pulses into the counter of figure 2 will produce the state shown in figure 3 at the 467 pulse, and in the process, 46 pulses will be put into the succeeding counter. That counter in turn will be in the 6th state (figure 3 at the 46th pulse) and it will pass on 4 pulses to the last counter, moving it to the 4th state. To display the number 467, we need to light up a 7 from the first counter, a 6 from the second, and a 4 from the third counter. The following example is worked out in detail to illustrate the logic involved.

The schematic, Figure 11, shows three NIXIE* tubes, all connected alike. V1, for example, is operated from the first counter and functions as the units (right-most) digit in the display. When a 1 is presented to Q19 it conducts and the 7 digit glows. Consequently, we need to present a 1 to Q19 if and only if the state of the counter is that illustrated in figure 3 after the 7th pulse.

This is done by connecting NOR gates to the appropriate outputs of the counter flip-flops. A NOR gate has the property of having a 1 output if and only if both inputs are 0. From figure 3, we see that C_0 and B_1 are both 0 only when the counter is in state 7. Consequently, the outputs C_0 and B_1 are connected

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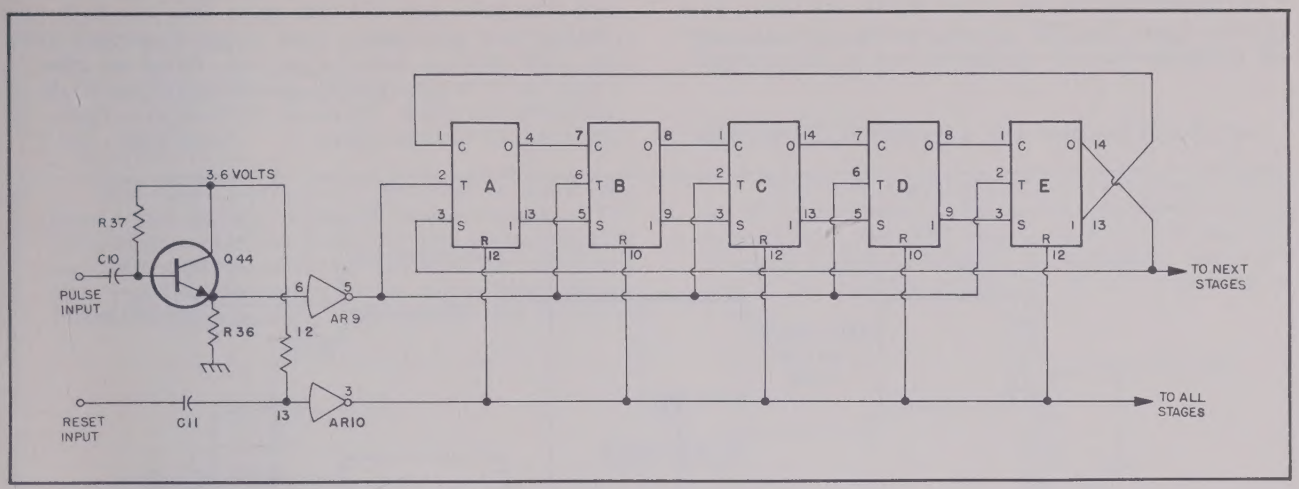

Figure 2

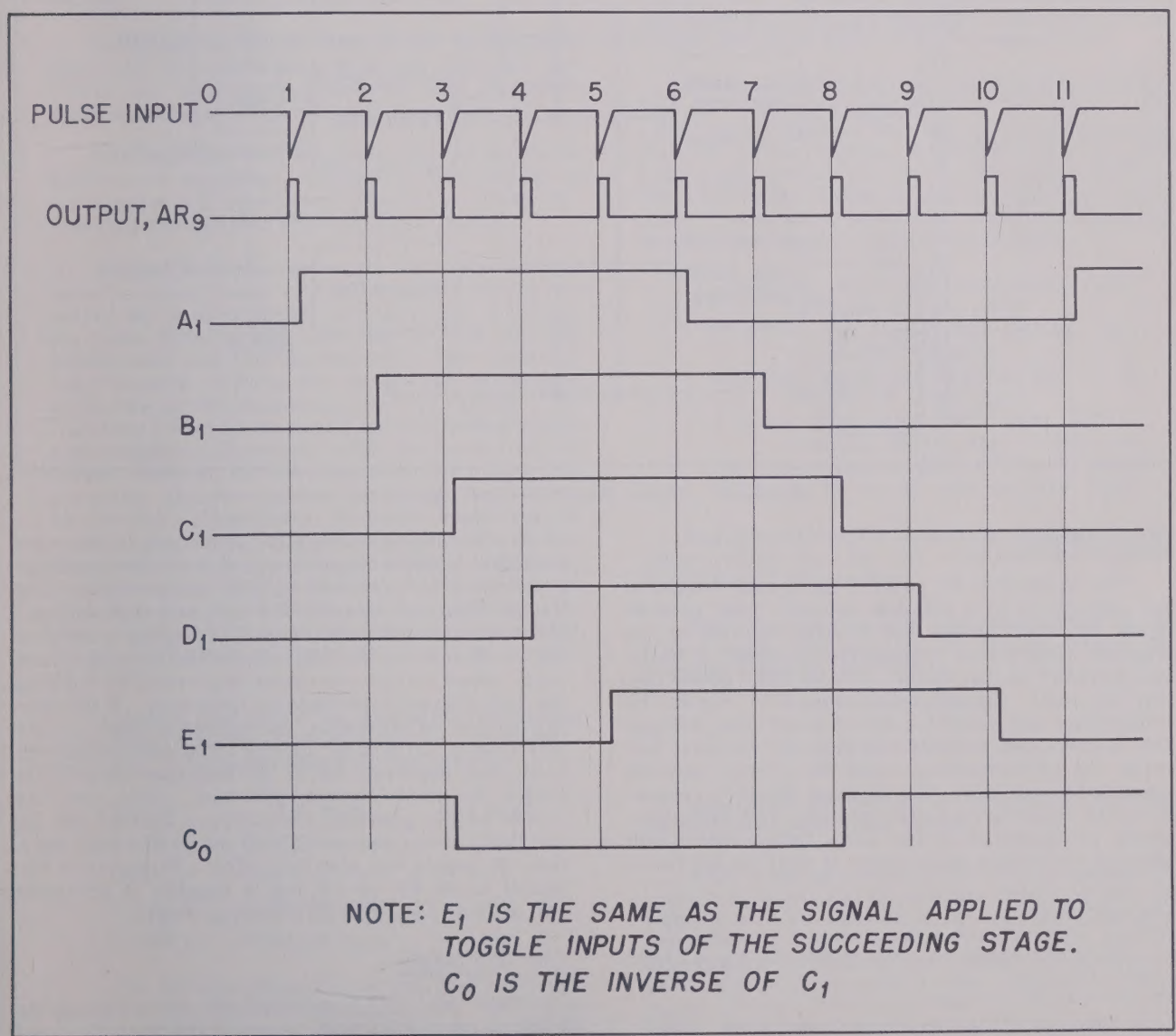
PULSE INPUT
0 1 2 3 4 5 6 7 8 9 10 11
OUTPUT, AR9
A1
B1
C1
D1
E1
C0
NOTE: E1 IS THE SAME AS THE SIGNAL APPLIED TO TOGGLE INPUTS OF THE SUCCEEDING STAGE.
C0 IS THE INVERSE OF C1

Figure 3

to a NOR gate and the output of that gate drives Q19. The connections for the other digits are shown in a table in figure 11. The logical process is similar and all three decades are connected in the same manner.

It should be noted that a counter of the type used here can have stable states other than those shown, and it is quite possible that more than one digit per NIXIE* tube may light. This commonly occurs when the DMS-3200 is first turned on. However, when a reset pulse is entered, the counters return to the 0 state and thereafter, the states illustrated in figure 11 are the only ones possible.

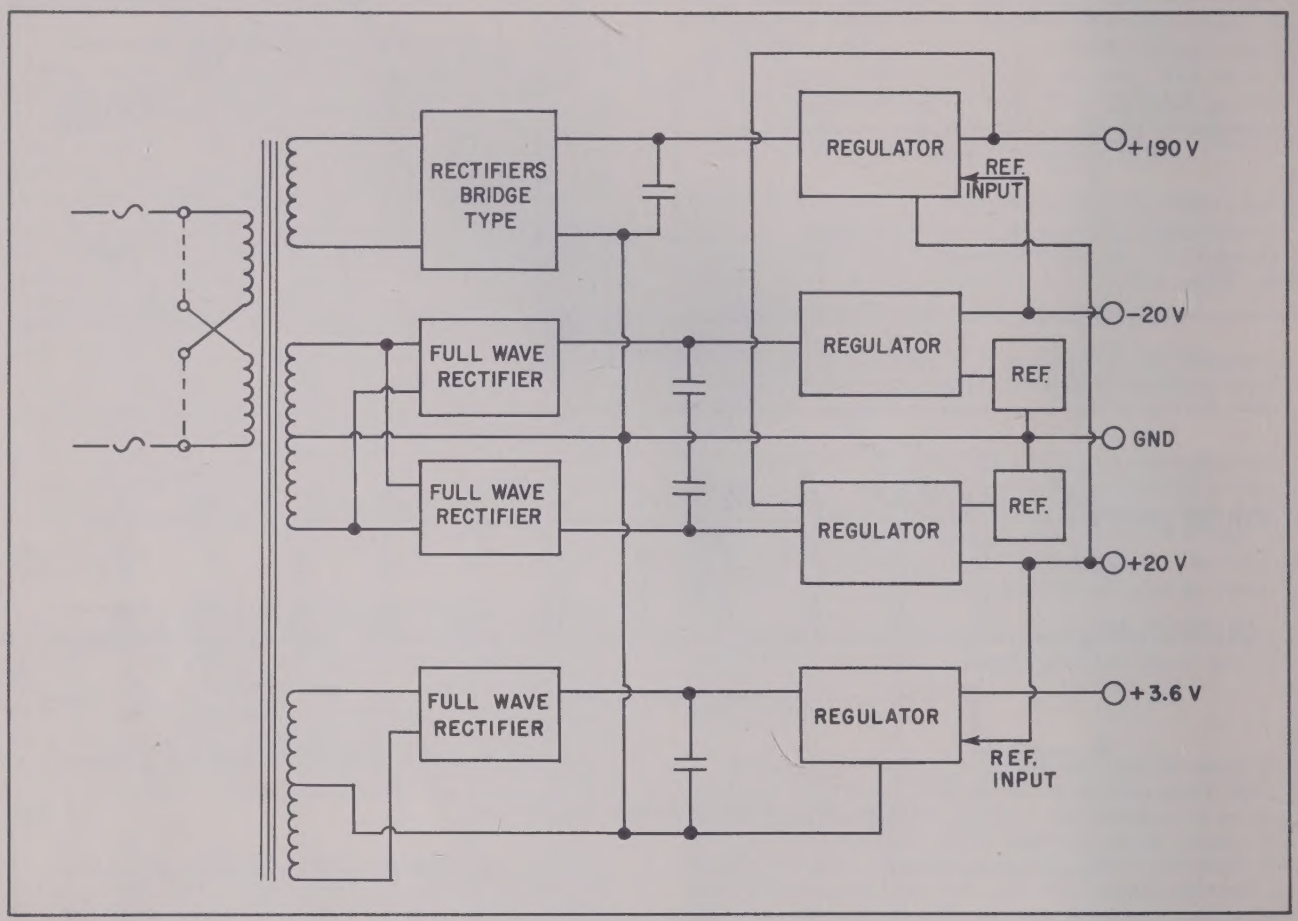

Figure 4. Power Supply Block Diagram

Power Supplies

There are four dc power supplies all regulated and referenced to a common ground. They provide power for the Counter and Readout as well as the plug-ins. One power transformer is used. It has a split primary so that either 115V or 230V power line may be used. The schematic, figure 11, shows the connections necessary for either power line voltage. Two electrostatic shields are present: the first between the primaries and core, the second between secondaries and core. The primary shield is returned to the third (green) wire ground. The secondary shield is connected to the main frame case. Both sides of the line are fused with 1/2 amp slo-blo fuses.

The + 20V Supply

The + 20V supply consists of a center tapped secondary winding providing about 39. 4V rms, a full wave rectifier, a filter capacitor, and a series regulator referenced by means of an 18V zener diode. The series regulator consists of a high gain feedback amplifier of conventional design. The passing transistor Q6 is mounted on the rear panel which acts as a heat sink. Short circuit protection is provided by limiting the base current to the passing transistor. If the supply current is excessive, the voltage dropped across R11 causes Q7's base current to be shunted into the load, thus depriving Q6 of its base current and this limits the total current delivered. Note that the + 190V supply provides the collector current for Q8 and the base current for Q7. If the + 190 supply fails, the + 20 supply will also fail. The + 20 supply is adjusted to 20. 0V ±0. 1V and is capable of providing 170 ma with less than 5mV average ripple.

The -20V Supply

The -20V supply is essentially the same as the + 20V supply except that p-type transistors are used

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instead of n-type. This supply also is adjusted to -20.0V ±0.1V and is capable of providing 30ma with less than 10mV average ripple.

The +190V Supply

The +190V supply uses a full wave bridge driven from a high voltage winding of the transformer. The filtered dc is also regulated with both the passing (Q3) and shunt (Q4) transistors mounted on the rear panel. This regulator is controlled by a precision voltage divider referenced to the -20V supply. It is protected against overloads in the same manner as the +20, and -20 supplies. It will supply 30ma at +190V ± 2%.

The +3.6V Supply

The +3.6V supply utilizes a low voltage winding on the transformer and a series regulator which is referenced to the +20V supply. It is protected against overload simply by limiting the maximum base current to the passing transistor. It will supply up to 1 amp.

III
SERVICE

General

No attempt should be made to service the DMS-3200 until the circuit description has been read and understood. Precautions should be taken to avoid a shock hazard since high voltages are present.

The first step is to determine whether the power supplies are functioning correctly. Malfunctions in the supplies will cause most plug-ins to operate incorrectly and can also affect the main counter.

Access to the power supply and main counter board is accomplished by removing the 4 screws securing the rear panel and pulling it back so that the top cover plate may be slid out. At this time the bottom plate may also be removed. Care should be taken to avoid straining the harness and connections to the transistors mounted on the rear panel. The transistors themselves should not be disturbed unless replacement is necessary. With the top and bottom covers removed, the rear panel may be reinstalled. Generally, this arrangement grants sufficient access for service. If necessary, the power supply may be removed completely by removing 2 screws holding the power switch to the front panel, and 4 screws securing the power supply chassis to the side extrusions. Then the plug-in connector located underneath the chassis may be disengaged and now the complete power supply, rear panel and power switch may be removed as a unit.

A dummy load should be connected to the supplies when they are disconnected from the main frame counter board. Convenient values of resistors are:

Supply	Full Load	Low Load
+20V	-120Ω, 10 watts	1k
-20V	-750Ω, 2 watts	4.7k
+3.6V	-3.6Ω, 10 watts	10
+190V	-63kΩ, 10 watts	120k

The voltages should be checked, preferably with a ±0.1% voltmeter. A DMS-3200 and DP-100 plug-in is good for this purpose. Ripple and noise can be observed with a sensitive (10mV/cm) oscilloscope or measured with a good wide band ac voltmeter having a 10mV full scale range.

The interrelations between supplies must be noted. The -20V supply is independent of all others. The +190V supply requires the -20V for its reference and the +20V for its reference amplifier to operate. The +20V supply needs +190 for its reference amplifier. The +3.6 supply needs the +20 supply for its reference. The following possibilities are listed assuming that the -20V supply is operating correctly:

+190 high, high ripple: Shorted Q3, open Q4, open Q5, low +20V .
+190 low, high ripple: high leakage, Q4, shorted Q5, Q3 open
+20 high, high ripple: shorted Q6, shorted Q7, CR15 open
+20 low, high ripple: R13 open, CR15 shorted, CR12, 13, 14 shorted
+3.6 high: shorted Q2 or Q1 (or +20 high)
+3.6 low: Q2 or Q1 open (or +20 low)

Regulation from low load to full load is approximately .1% for the +20, -20, +190 supplies and about 5% for the +3.6V supply.

With the main counter board connected to the power supply, the supplies are able to deliver the following currents to a plug-in:

+20V	-	160ma
-20	-	30ma
+3.6	-	250ma
+190	-	15ma

Regulation will be lost if the current drawn by the plug-in exceeds these values.

After it has been determined that all supplies are performing correctly, the voltages of the +20 and -20 supplies may be adjusted by means of R14 and R17 respectively. These supplies have a slight positive temperature coefficient, and should be allowed to warm up for 15 minutes before final adjustment. Their output voltage should be set between 19.95 and 20.00 volts.

If any components are to be replaced, it is very important to observe the procedures outlined on page 9. A low soldering iron tip temperature is very important. If the iron's temperature is too high, the adhesive bond between the glass-epoxy circuit board and the copper laminate will be destroyed. Also, the copper laminate may be torn loose if much strain is applied. The recommended procedure for removing a component, if carefully followed, will result in clean, neat repairs without these difficulties.

Replacement of the power transistors mounted on the rear panel must be done carefully with a heat sink compound so that thermal conductivity is maintained while the transistors are electrically isolated. After installation, the insulation between transistors and rear panel should be checked by applying 1000V in series with a 2 watt 10MΩ resistor between the transistor (any lead) and the rear panel. Current flow should not exceed 1/10μamp.

The Main Counter Board

It is most important to check the power supplies as outlined above before attempting to service the Main counter board. All the following discussion assumes that this has been done. Access for trouble shooting may be obtained by removing the top and bottom cover plates as described above. Then, with no plug-in present, both the top and bottom of the main counter board are accessible. With no plug-in connected, the circuit ground should be connected to the case by placing a jumper from pin 1 of the power supply connector to the chassis. Problems may be isolated to either the display circuitry or the counter circuitry.

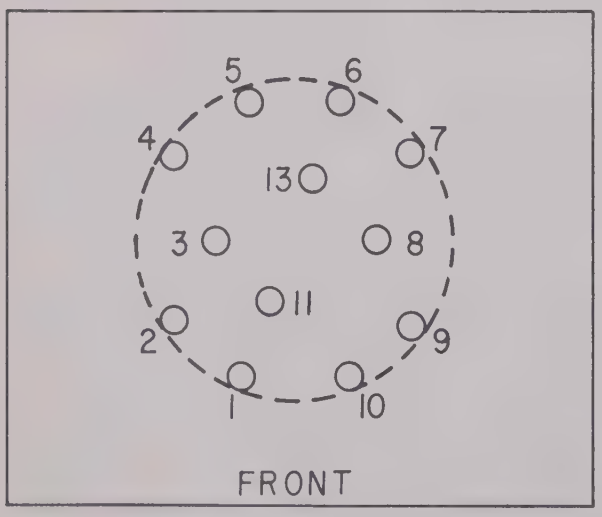


Figure 5.

Display

If a particular number refuses to light, then ground the appropriate socket pin. The number should light. Figure 5 shows the pin layout as viewed from the bottom. If the number is still dark, replace the tube. The tube securing clamp is removed by gripping it in the middle and pulling up, bowing it slightly.

If a particular number is lighted all the time, ground the base of the appropriate driver transistor. If the number remains lighted, either the tube has an internal short and should be replaced or the driver transistor is shorted and should be replaced.

If it has been determined that the display tube is good, and the driver transistor is not shorted, the trouble shooter must examine the corresponding NOR gate. Figure 6 illustrates the circuitry which drives the number 7 of the first digit.

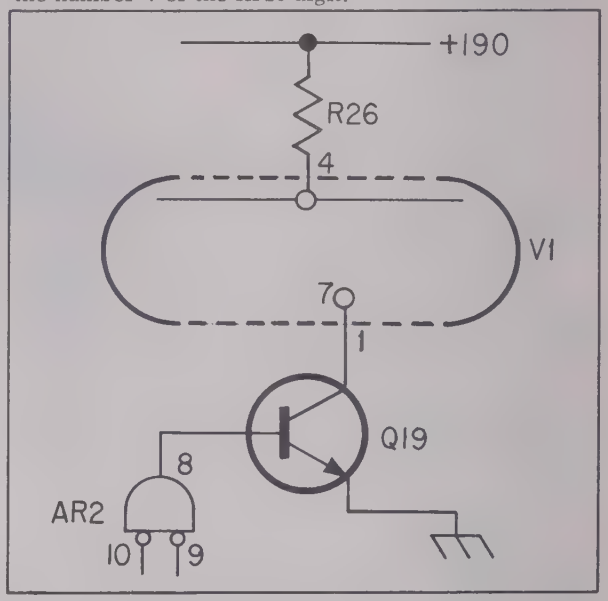


Figure 6.

Figure 10 shows where the integrated circuit package, AR2, is located. The small numbers indicate the package pin numbers. The schematic, Figure 11, shows package pin numbers throughout.

To check the NOR gate shown, both inputs (pins 9 and 10) should be connected to ground with jumpers. At this point, the voltage at the base of Q19 should exceed +0.6V and Q19 should saturate, lighting the number 7. The lighting of other numbers within V1 should be ignored. If there is trouble, replacing Q19 is much easier than replacing the package AR2 and should be done first.

If the above checks show that the tubes, driver transistors and NOR gates are operative, troubles may be assumed to lie in the counters themselves. However, if a NOR gate has a shorted input, then this will disrupt the counter, and the above checks will not reveal this condition.

Counters

The only approach to servicing the counters is to understand thoroughly the logic of their operation as outlined in "Circuit Description" above. The waveforms shown in figure 3 are the best guide. Figure 11 identifies the package and pin numbers and figure 10 shows their physical location. Patience and pencil and paper to write down observed states are necessary.

For the purposes of examining the counter operation, a square wave signal generator may be connected to pin 1 of the rear subpanel connector to provide a count pulse. A 3V peak to peak square wave is sufficient. A reset pulse may be generated by connecting pin 14 to the 3.6V supply through a 1k resistor and then shorting pin 14 to ground.

A particular flip-flop may be checked for proper toggle operation. Short its set and clear inputs to ground, make sure its reset input is at ground level, and then turn on the square wave generator so that a toggle pulse is obtained. With an oscilloscope, observe the "1" and "0" outputs: a square wave should be obtained from both at 1/2 the frequency of the signal appearing at the toggle input.

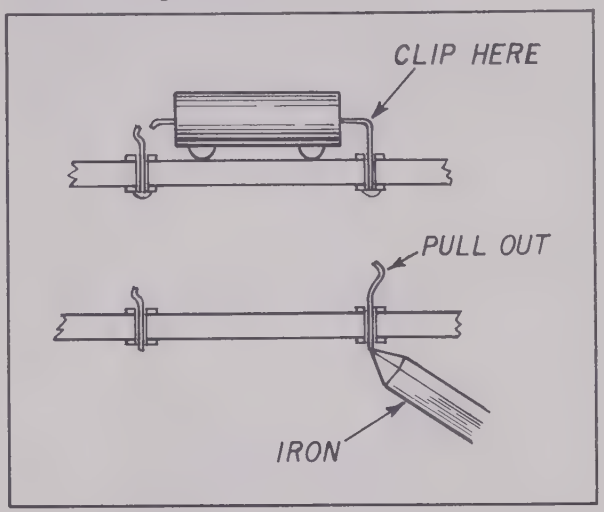
However, if either output of the JK flip-flop is shorted to ground either by a short on the board, or by a defective NOR gate, the JK will not operate until the short is removed.

If both sides of the flip-flop remain at 0 level, check for Vcc of +3.6V on pin 11 of the package.

If one side remains at a 0 level while the other side performs normally, replace the package.

If both sides remain at a 1 level, check for an improper ground connection around pin 4.

In all cases the service man should attempt to replace a package reluctantly and only after all other alternatives have been explored. There will be cases where it is impossible to determine precisely which package to replace, and one must just guess. In some cases the package can be isolated by clipping a package lead. This must be done with great care to avoid undue mechanical strains on the board pad or the package. Figure 7 illustrates the removal method. Again, the lowest possible soldering iron temperatures must be used. Caution must be used to avoid serious damage to the board.

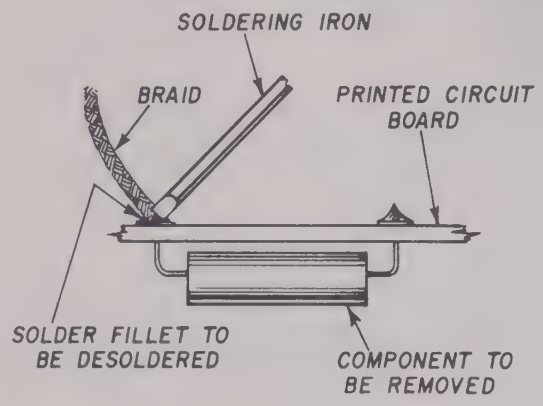


Clean holes with a piece of .020 stainless steel wire by melting the solder and poking the wire through.

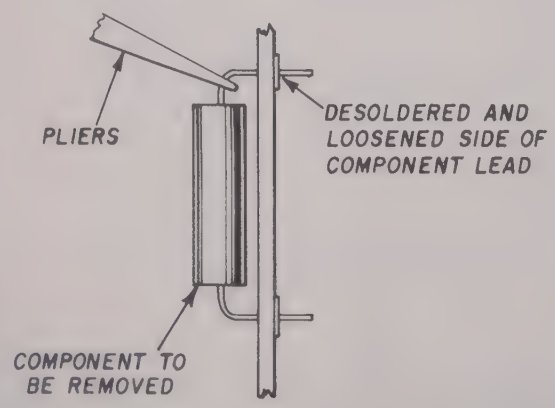
Figure 7.

PROCEDURE FOR REPLACING COMPONENTS IN PRINTED CIRCUIT BOARDS

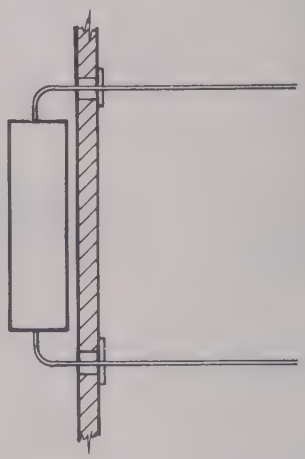
1. Place printed circuit in the horizontal position with the soldered side up. Take a length of fine braid or fine stranded wire either tinned or not tinned. Braid is preferable. Dip the end of the braid in resin flux (London Chemical Co. type #77-33-TA or equivalent). Place the fluxed end of the braid on a solder fillet of the component to be removed. Press the braid on to the fillet using the clean tip of the soldering iron. Do not overheat the board or component. Only heat the solder fillet sufficient to melt the solder. The solder will "wick" up the braided wire removing the solder from the joint. Continue this process until all leads of the component to be removed are free of solder.



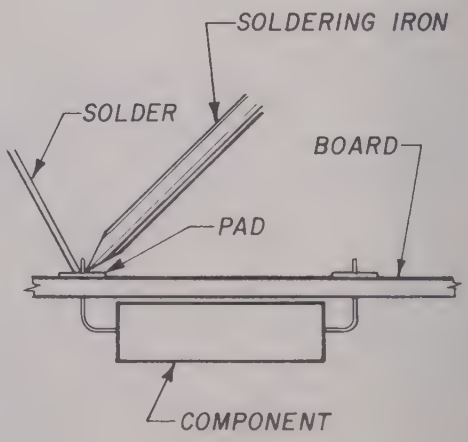
2. Using a pair of needle nose pliers "wiggle" each lead of the component to be removed to be sure it is free of the land area to which it was soldered. Place the needle nose pliers on the component lead and remove the lead. Continue the procedure with each component lead until the component is removed. Do not force the leads. If a lead can not be removed touch the lead on the soldered side of the board with the soldering tip.



3. Bend clean tinned leads of new component and carefully insert in holes. (Do not force component. If it does not insert easily reheat pad and clean as before).



4. Hold part to board and solder leads from print side of board. Do not leave a large blob of solder on pad. The correct amount can be determined by observing other connections made in production.



The above should be carefully followed or extensive damage to the printed circuit board will result.

Figure 8 Servicing Etched Circuit Boards

SERVICING PRINTED CIRCUIT BOARDS

Excessive heat or pressure can lift copper print from the board. For this reason a low power soldering iron should be used, preferably operating at reduced temperature. This can be achieved by connecting the iron to a variac or other line control device by which the line voltage can be reduced.

If a copper strip is lifted from the board, the area of the board surrounding the strip should be thoroughly cleaned. Then the strip should be cemented in place with a quick drying acetate base cement having good electrical insulating properties. If there is a break in a strip a small length of tinned copper wire should be soldered across the break. Care should be taken to avoid shorting two tapes together with a solder bubble.

When soldering on printed circuit boards only high-quality rosin core solder should be used. After soldering, the board should be thoroughly cleaned using Printed Circuit Cleaner manufactured by the John B. Moore Co., followed by a rinse in either Freon T-F or Genesolv D to remove all traces of flux.

CAUTION: Never use chlorinated solvents as they will attack various circuit components.

After cleaning, a coating of Dow Corning DC200 silicone oil should be applied to the board. This can be accomplished by putting a small quantity of the DC200 (about 2 fluid oz. DC200 to 1 gallon Freon T-F) in the Freon T-F solvent. Care should be taken not to apply excessive oil as it tends to pick up dirt and dust. If a correct coating is applied the board should not appear oily but it should feel oily to the touch. If the printed circuit board has been previously damaged, or the above procedure is impractical, the following procedure may be used:

1. Clip leads of component to be replaced as close to the component as possible.

2. Bend the clipped leads upward. Bend the leads of the new components around the protruding leads. Apply solder, using a pair of long-nosed pliers as a heat sink.

NOTE

THIS PROCEDURE IS NOT RECOMMENDED AS A PERMANENT COMPONENT REPLACEMENT PROCEDURE, AND IS NEVER USED WITHIN THE HICKOK FACTORY OR SERVICE FACILITIES.

PLUG-IN CONNECTOR CIRCUIT FUNCTIONS, J1

Pin	Function
1	Count Input
2	Circuit ground
3	+20 volt supply
4	+190 volt supply
5	Extreme left decimal point
6	Second decimal point from right
7	Vertical bar of ± sign
8	+3.6 volt supply
9	Reset to 000 overrange off
10	Power line frequency to plug-in
11	-20 volt supply
12	Wrong Polarity Indicator
13	Second decimal point from left
14	Extreme right decimal point
15	Horizontal bar of ± sign
16	Hundred's counter output

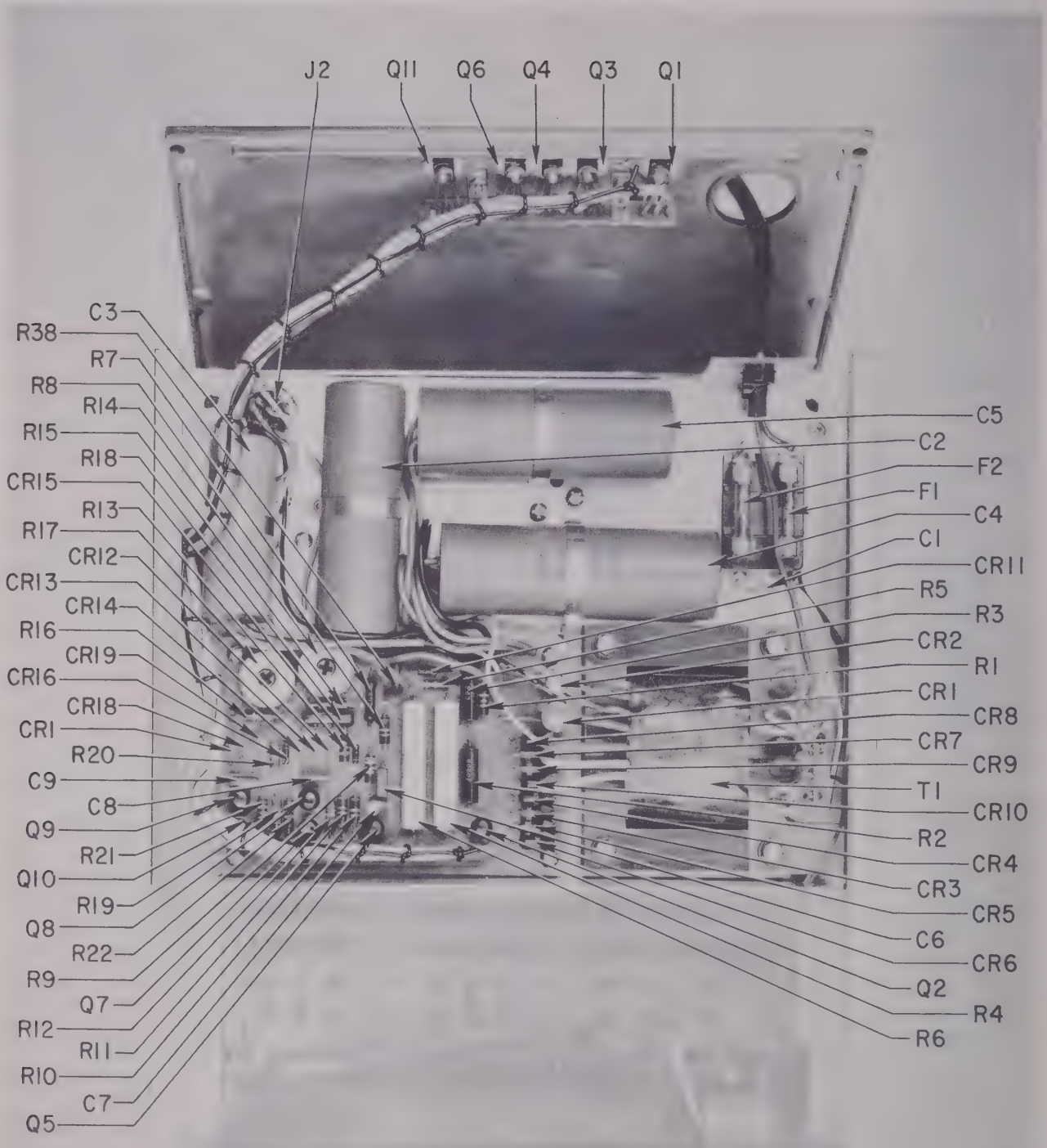


Figure 9 Component Locations -- Power Supply

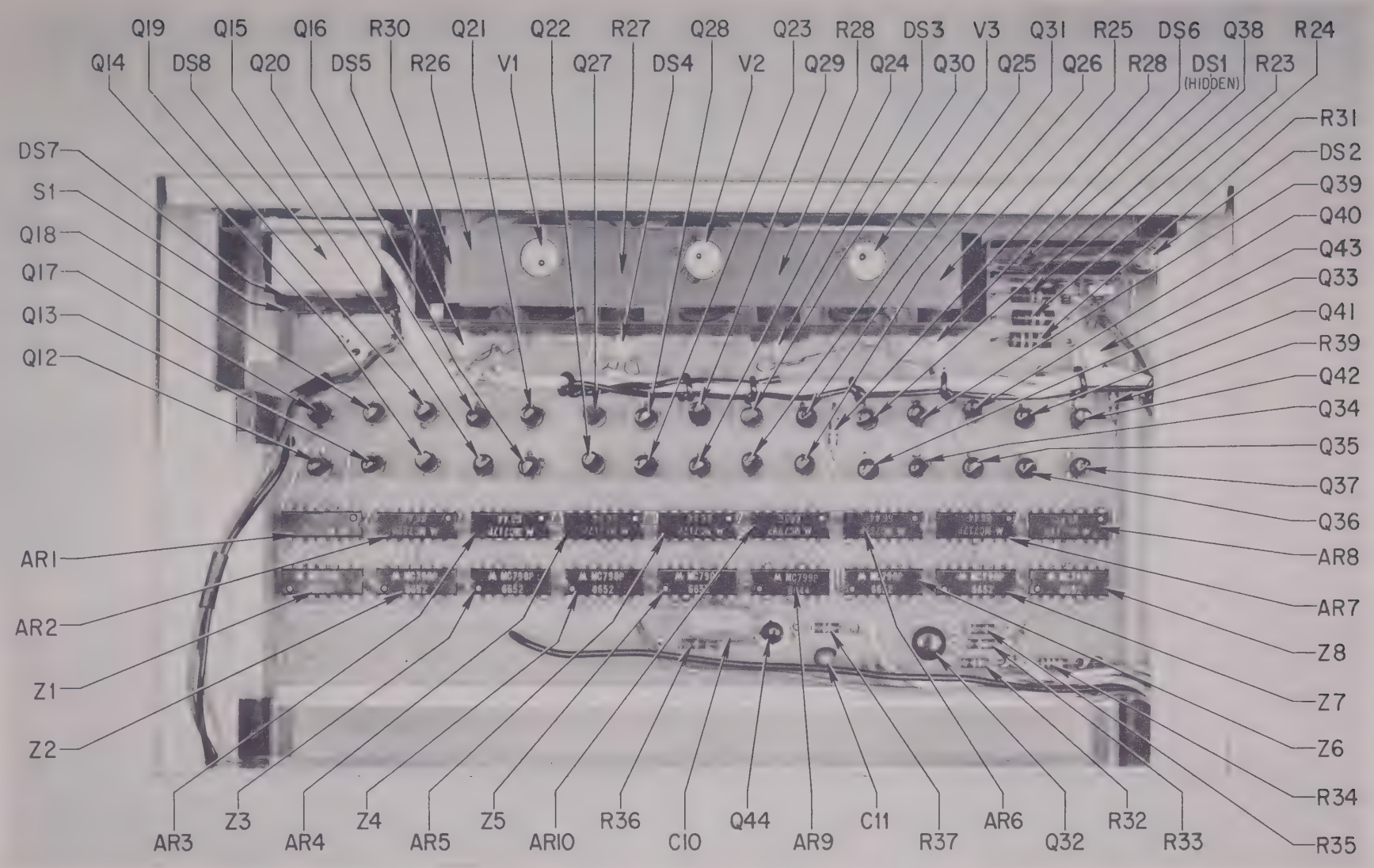


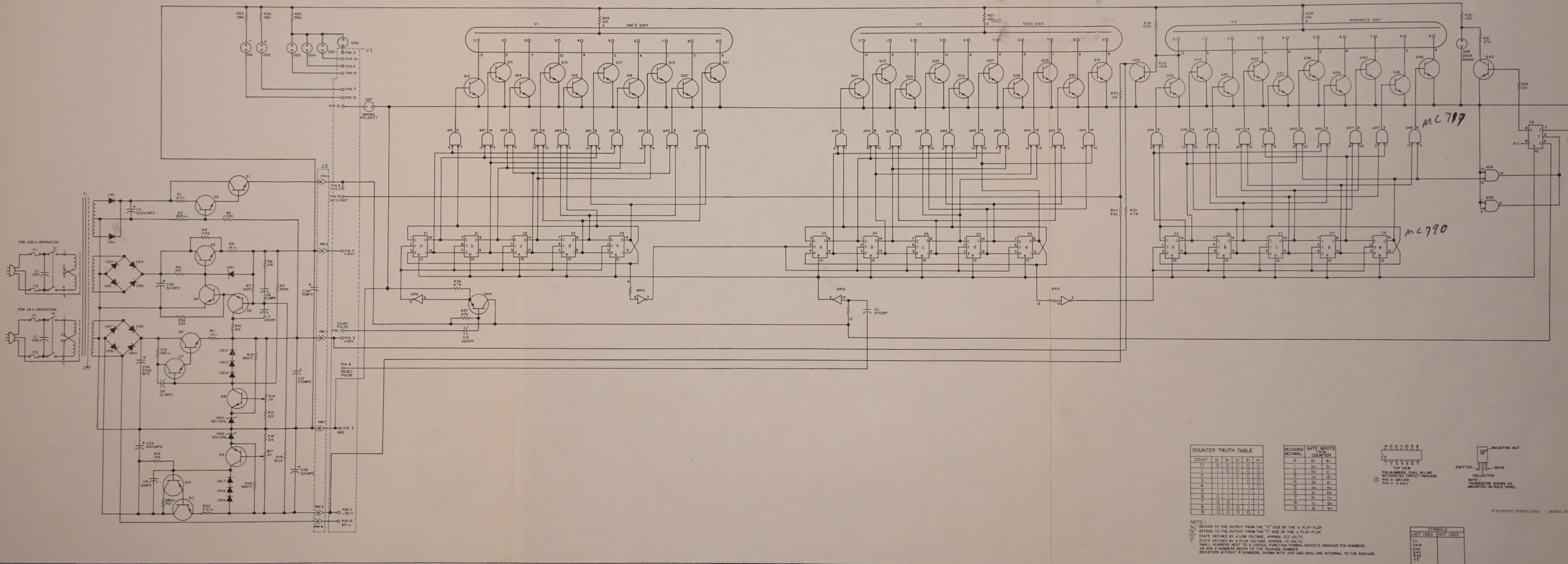
Figure 10 Component Locations -- Main Counter Board

PARTS LIST

Reference designations are assigned to identify all parts of the Model DMS3200 Digital Measuring System Main Frame. These designations are used in the parts list and the schematic wiring diagram. The letter prefix of a reference designation indicates the kind of part - resistor, capacitor, electron tube, integrated circuit, etc. The number differentiates between parts in the same group.

REF. DESIG.	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
AR1	INTEGRATED CIRCUIT: dual input Quad Milliwatt Gate	9800-2	2.18
AR2	Same as AR1		
AR3	Same as AR1		
AR4	Same as AR1		
AR5	Same as AR1		
AR6	Same as AR1		
AR7	Same as AR1		
AR8	Same as AR1		
AR9	INTEGRATED CIRCUIT: dual buffer element	9800-3	2.18
AR10	Same as AR9		
C1	CAPACITOR, FIXED, POLYESTER FILM: .033μF, 10%, 400V	3092-407	.60
C2	CAPACITOR, FIXED, ELECTROLYTIC: 10,000μF, 6V	3085-314	1.56
C3A, B	CAPACITOR, FIXED, ELECTROLYTIC: 50μF @ 300V and 10μF @ 300V	3085-313	1.18
C4A, B	CAPACITOR, FIXED, ELECTROLYTIC: 2700μF @ 30V and 270μF @30V dual section	3085-311	2.14
C5A, B	CAPACITOR, FIXED, ELECTROLYTIC: 1000μF @ 30V and 100μF @ 30V dual section	3085-312	2.20
C6	CAPACITOR, FIXED, POLYESTER FILM: .1μF, 10%, 200V	3103-30	.80
C7	CAPACITOR, FIXED, CERAMIC: 470pF, 20%, 500V	3111-520	.46
C8	CAPACITOR, FIXED, POLYESTER FILM: .01μF, 10%, 200V	3103-39	.68
C9	Same as C8		
C10	CAPACITOR, FIXED, CERAMIC: 1000pF, +50 - 20%, 500V	3111-522	.46
C11	CAPACITOR, FIXED, CERAMIC: 4700pF, +50% -20%, 500V	3111-526	.46
CR1	SEMI-CONDUCTOR DEVICE: 1N4719 rectifier, silicon	3870-183	1.20
CR2	Same as CR1		
CR3	SEMI-CONDUCTOR DEVICE: 1N2070 rectifier, silicon	3870-158	.78
CR4	Same as CR3		
CR5	Same as CR3		
CR6	Same as CR3		
CR7	SEMI-CONDUCTOR DEVICE: 1N2069 rectifier, silicon	3870-62	.78
CR8	Same as CR7		
CR9	Same as CR7		
CR10	Same as CR7		
CR11	SEMI-CONDUCTOR DEVICE: 1N710A zener, 6.8V ±5%	3870-178	3.28
CR12	SEMI-CONDUCTOR DEVICE: 1N914	3870-175	.66
CR13	Same as CR12		
CR14	Same as CR12		
CR15	SEMI-CONDUCTOR DEVICE: zener diode 1/4M18Z5, 18V ±5% at 3.5ma	3870-184	1.60
CR16	Same as CR15		
CR17	Same as CR12		
CR18	Same as CR12		
CR19	Same as CR12		
DS1	LAMP: neon indicator NE2H	12270-72	.58
DS2	Same as DS1		
DS3	LAMP: pilot light for decimal points neon source	12270-71	.72
DS4	Same as DS3		
DS5	Same as DS3		
DS6	Same as DS3		
DS7	LAMP: readout pilot light, "Wrong Polarity"	12270-69	1.14
DS8	LAMP: readout pilot light, "Over Range"	12270-68	1.14
F1	FUSE: 1 amp, SLO-BLO	6900-5	.64
F2	Same as F1		
Q1	TRANSISTOR: MJE-520 NPN silicon, low voltage high power	20861-129	2.32
Q2	TRANSISTOR: 2N3566, NPN silicon, general purpose	20861-122	.89
Q3	TRANSISTOR: SJE 205 NPN silicon high voltage, selected	20861-135	2.44
Q4	Same as Q3		
Q5	Same as Q2		

REF. DESIG.	NAME AND DESCRIPTION	HICKOK PART NO.	PRICE EACH
Q6	Same as Q1		
Q7	Same as Q2		
Q8	Same as Q2		
Q9	TRANSISTOR: 2N3638 NPN silicon general purpose	20861-65	1.08
Q10	Same as Q9		
Q11	TRANSISTOR: MJE-370 PNP silicon, low voltage high power	20861-128	2.78
Q12	TRANSISTOR: A130 NPN silicon high voltage	20861-77	1.38
Q13 thru Q31	Same as Q12		
Q32	Same as Q2		
Q33 thru Q42	Same as Q12		
Q43	TRANSISTOR: A130-1, 130V, NPN silicon	20861-78	2.14
Q44	TRANSISTOR: 2N3646 NPN silicon, high frequency	20861-73	1.38
R1	RESISTOR, FIXED: 4.7 ohms, 10%, 1/2W	18525-937	.46
R2	RESISTOR, FIXED, METAL FILM: 806 ohms, 1%, 1/2W	18525-939	.58
R3	RESISTOR, FIXED, METAL FILM: 2.32K ohms, 1%, 1/2W	18525-938	.58
R4	RESISTOR, FIXED, WIRE WOUND: 7.5K ohms, 10%, 10W, ceramic encapsulated	18575-504	.62
R5	RESISTOR, FIXED: 91 ohms, 5%, 1/2W	18410-911	.52
R6	RESISTOR, FIXED, WIRE WOUND: 10K ohms, 10%, 10W, ceramic encapsulated	18575-507	.62
R7	RESISTOR, FIXED, METAL FILM: 162K ohms, 1%, 1/2W	18525-865	.60
R8	RESISTOR, FIXED: 10K ohms, 10%, 1/2W	18413-102	.46
R9	RESISTOR, FIXED: 390K ohms, 10%, 1/2W	18414-392	.46
R10	Same as R8		
R11	RESISTOR, FIXED: 1.2 ohms, 10%, 1/2W	18525-816	.46
R12	RESISTOR, FIXED: 560 ohms, 10%, 1/2W	18411-562	.46
R13	RESISTOR, FIXED: 680 ohms, 10%, 1/2W	18411-682	.50
R14	RESISTOR, VARIABLE: wire wound, 2K ohms, printed circuit mounting	16925-568	.76
R15	RESISTOR, FIXED: 12K ohms, 10%, 1/2W	18413-122	.46
R16	Same as R15		
R17	Same as R14		
R18	RESISTOR, FIXED, FILM: 18.2K ohms, 1%, 1/2W	18525-868	.58
R19	RESISTOR, FIXED: 15K ohms, 10%, 1/2W	18413-152	.46
R20	Same as R13		
R21	Same as R13		
R22	RESISTOR, FIXED: 2.2 ohms, 10%, 1/2W	18525-819	.46
R23	RESISTOR, FIXED: 56K ohms, 10%, 1/2W	18413-562	.46
R24	Same as R23		
R25	Same as R23		
R26	Same as R19		
R27	Same as R19		
R28	RESISTOR, FIXED: 150K ohms, 10%, 1/4W	18454-152	.46
R29	Same as R19		
R30	Same as R23		
R31	RESISTOR, FIXED: 27K ohms, 10%, 1/2W	18413-272	.46
R32	RESISTOR, FIXED: 10K ohms, 10%, 1/4W	18453-102	.46
R33	RESISTOR, FIXED: 100K ohms, 10%, 1/4W	18454-102	.46
R34	RESISTOR, FIXED: 33K ohms, 10%, 1/4W	18453-332	.46
R35	RESISTOR, FIXED: 4.7K ohms, 10%, 1/4W	18452-472	.46
R36	Same as R35		
R37	RESISTOR, FIXED: 47K ohms, 10%, 1/4W	18453-472	.46
R38	RESISTOR, FIXED: 22K ohms, 10%, 1/2W	18413-222	.46
R39	Same as R32		
S1	SWITCH: rocker type dpst	19911-91	1.52
T1	TRANSFORMER: power	20800-348	11.18
V1	TUBE: nixie, type NL856	20875-263	12.40
V2 & 3	Same as V1		
Z1 thru Z8	INTEGRATED CIRCUIT: dual JK FLIP-FLOP	9800-1	3.56
	BOOKLET: instructions	2490-561	



COUNTER TRUTH TABLE					
COUNT	a_1	b_1	c_1	d_1	e_1
0	0	0	0	0	0
1	1	0	0	0	0
2	1	1	0	0	0
3	1	1	1	0	0
4	1	1	1	1	0
5	1	1	1	1	1
6	0	1	1	1	1
7	0	0	1	1	1
8	0	0	0	1	1
9	0	0	0	0	1

DECODED DECIMAL	GATE INPUTS FROM COUNTER
0	a_1 e_1
1	a_0 b_1
2	b_0 c_1
3	c_0 d_1
4	d_0 e_1
5	a_0 e_0
6	b_1 b_0
7	b_1 c_0
8	c_1 d_0
9	d_1 e_0

TOP VIEW
PIN NUMBERS, DUAL IN-LINE INTEGRATED CIRCUIT PACKAGE
PIN 4 GROUND
PIN 11 + 3.6 V

MOUNTING NUT
EMITTER — BASE
COLLECTOR
NOTE: TRANSISTOR SHOWN AS MOUNTED ON BACK PANEL.

NOTE -
"a_0" REFERS TO THE OUTPUT FROM THE "0" SIDE OF THE a FLIP-FLOP
"a_1" REFERS TO THE OUTPUT FROM THE "1" SIDE OF THE a FLIP-FLOP.
"0" STATE DEFINED BY A LOW VOLTAGE, APPROX. 0.2 VOLTS.
"1" STATE DEFINED BY A HIGH VOLTAGE, APPROX. 13 VOLTS.
SMALL NUMBERS NEXT TO LOGICAL FUNCTION SYMBOL INDICATE PACKAGE PIN NUMBERS.
AR AND Z NUMBERS REFER TO THE PACKAGE NUMBER.
RESISTORS WITHOUT R NUMBERS, SHOWN WITH AR9 AND AR10, ARE INTERNAL TO THE PACKAGE.

SYMBOLS	
LAST USED	NOT USED
C11	
CR19	
DS5	
Q43	
R39	
V3	

SCHEMATIC WIRING DIAG. - MODEL 3200A